The Academies Come to Los Alamos for a Summer of Science

Trent Jones, a junior at West Point, came to Los Alamos National Laboratory to explore the practical applications of his major, physics.

"I wanted to see how, exactly, physics is used in the world today," Jones said.

He spent four weeks working with a Laboratory mentor in the Materials Science and Technology Division, where most of his time was spent doing what he, as a physicist, says he loves to do: "work on a small scale." Alongside Laboratory technical staff members, he helped characterize materials, determining their internal structure and properties.

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The materials Jones worked with were destined for use in experiments at the Laboratory's Dual-Axis Radiographic Hydrodynamic Test (DARHT) facility. DARHT's "dual axis" consists of two linear accelerators, set at right angles to each other, that focus electron beams on a single thin metal target. At the target the beams' energy is converted into x-rays that are used to image the mock-up (no pluotonium) of a nuclear weapon primary as it implodes during experiments (see p. 41 in "Then & Now").

Jones, along with some of his team members, was also given some housekeeping work. He helped remove impurities from tantalum foils before they were used as DARHT targets. The foils were placed in an acid bath that was then exposed to ultrasonic waves.

"My high school chemistry teacher would be jealous. I got to work with nitric and hydrofluoric acid in really high concentrations," Jones said.

With plenty of hands-on work to be done, Los Alamos National Laboratory was the perfect place for Jones and 25 other students from U.S. military academies to spend part of their 2013 summer. Los Alamos hosted the 26 cadets

and midshipmen through the Service Academies Research Associates (SARA) program. Los Alamos' annual summer SARA program brings students from the U.S. military academies to Los Alamos, where they get practical academic experience by working at the Laboratory for four to six weeks. The National Nuclear Security Administration's Military Academic Collaboration program provides the funding to support the SARA program, which is designed to reinforce classroom experiences with real-world scientific projects that support the Lab's national security mission.

"The purpose of the SARA program is to help create more scientifically aware military decision makers who understand and appreciate the science and technology capabilities of the Lab," says Jon Ventura, who leads the Laboratory's SARA program.

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When students come to the Laboratory, they leave an academic environment of "practice problems" and enter a lab environment where they can take on unsolved problems that impact the world of science.

"We put them to work on problems that have a direct bearing on each student's academic program—and on the work of the Laboratory," says Ventura.

Students have the opportunity to work one-on-one with mentors and other LANL staff members on a large variety of projects in a lab environment that allows them to learn and contribute. Mentors volunteer to teach students about their specific area of expertise and introduce students to new scientific and technical topics.

Several of the 2013 participants worked with co-mentors Tim Goorley and Avneet Sood, group leaders in the Laboratory's Computational Physics Division. Goorley says his students used Monte Carlo computer codes to model the interaction of radiation with different materials. Students simulated how neutrons traveled through and interacted with a cylinder of highly enriched uranium, creating gamma rays that were then picked up by a sensor. They then compared the results of their simulation with experimental data to see how accurate the simulation was.

Todd McLaughlin, a junior at West Point, worked with the life-extension program (LEP) for the B61, a LANL-designed thermonuclear bomb. The B61, like all weapons in the stockpile, is getting progressively older, and Los Alamos is responsible for keeping the bomb safe, secure, and reliable.

A midshipman from Annapolis, Nicholas Butler, worked on the Superconducting Quantum Interference Device (SQUID) team. SQUIDs are small devices (typically a millimeter in size and connected to centimeter-size "pick up" coils); they measure ultralow magnetic fields.

SQUIDs can do many jobs. For example, they can detect metal particles even 10,000 times smaller than the diameter of a human hair—nanoparticle size—and that means SQUIDs can be used to detect cancer cells. They can do that through the use of ultralow magnetized nanoparticles of iron oxide.

The iron oxide particles are nontoxic. They can be attached to cancer-specific antibodies and together with them, be injected into a patient's body. The antibodies with their hitchhiking magnetized nanoparticles bind to receptors on the cancer cells. A SQUID-based MRI (magnetic resonance imaging) device can then detect and image the iron oxide nanoparticles, revealing the location of the cancer cells for diagnosis and targeted treatment.

SQUID technology may also be used in a new class of MRI machine. The SQUID team is using this technology to develop an easily portable, lightweight MRI device. Butler said this project was especially exciting because the small SQUID-based MRIs will be suitable for use in places without access to large, conventional MRI machines, such as combat support hospitals.

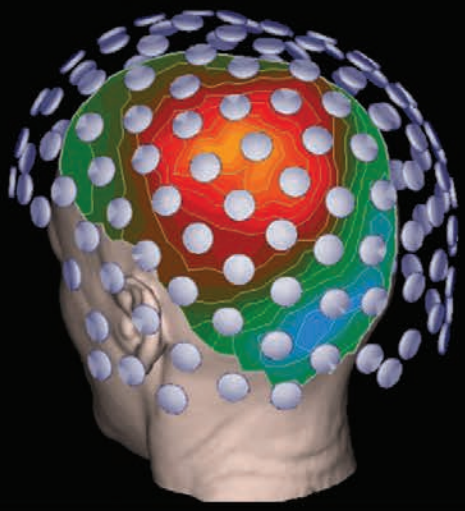
There is a wide variety of projects at Los Alamos for students like Jones, McLaughlin, and Butler. LANL offers students learning experiences across a vast set of scientific disciplines, with staff members eager to share their knowledge and expertise. Students and staff collaborate on projects, and Goorley says communicating with students is as valuable for the scientists as it is for the students. It gives students an opportunity to learn from the experts, and it allows staff members to practice sharing complex ideas in a way that others can understand.

Christopher Wink, a West Point cadet assigned to the Neutron Science and Technology group, said his team did a great job of making sure he fully understood what he was working on and why it was relevant.

"Everyone I worked with did a really good job of bringing me up to speed even though I don't have, like, three PhDs," Wink joked.

> **The environment at the Laboratory allows ideas to flow.**

SARA students also provide a fresh look at problems facing LANL, and they may come up with new ideas. West Point's Steven Sloan, for example, reviewed the way the Los Alamos Plutonium Facility processes plutonium-238 (Pu-238). Los Alamos purifies Pu-238 and compresses the material



Battlefield SQUIDs

Current magnetic resonance imaging (MRI) scanners use a powerful magnetic field to generate images of soft body tissue.

Although they produce detailed images, they have a few drawbacks. They use very large, heavy, strong magnets that can cause metal in a patient's body to move or get hot and expand, causing trauma. Today, many people have medically necessary metal implants such as pacemakers, and combat wounds often contain metal shards and bullet fragments. Also, MRI machines are typically large, not portable, and expensive (over $1 million).

SQUID-based ultralow-field MRIs, on the other hand, do not require a strong magnetic field—the field is 30 to 30,000 times smaller—so SQUID-based MRI scanners are safe for patients with metal in their bodies. SQUIDs allow the scanners to be compact, portable, and inexpensive.

The SQUID team at Los Alamos is working to create an MRI scanner that can be taken where it is needed, that is, to poorer countries and to the battlefield to support our troops.

Air Force cadet Steven Owens works at his computer for the Space Science and Applications group. He worked on a project called "Wide Field-of-View Plasma Spectrometer," which is developing a new type of instrument to measure plasmas (gases of charged particles) in space. (Photo: Los Alamos)

into pellets that can be used in radioisotope thermoelectric generators, "batteries" that have provided power for several NASA space missions. Sloan was able to suggest ways that Los Alamos could process these pellets in a more efficient, cost-effective way. McLaughlin said he was able to contribute a new idea to help the LEP for the B61.

"The environment at the Laboratory really allows ideas to flow, and it's easy to work with everybody. Anybody can contribute at Los Alamos," McLaughlin said. "One of the biggest things I've learned here is that students should not discount themselves from having brilliant ideas."

Mentoring is a great way to bring in new perspectives, but it is also an extra duty for LANL staff members, who voluntarily teach SARA students, often for personal reasons. Both Goorley and Patrice Stevens, who works in the Plutonium Facility, say they got involved with mentoring students because the military is in their blood. Stevens and Goorley come from military families and see the SARA program as a way to give back.

> **You cannot be successful doing high-level science without a mentor.**

Stevens had a mentor when she first came to the Lab, and she says her experience is another reason she mentors SARA students today. Her mentor was a huge part of her life inside and outside of the Lab and, she says, showed her the ropes and led her through the world of science. According to her, no one can be successful doing high-level science without a mentor who both teaches and takes care of the mentee. She believes the mentoring relationship with SARA students is about getting them involved with problem solving and showing them the wide range of possibilities at the Lab.

To supplement their in-depth learning with mentors and other LANL staff members, students explore the variety of work at the Laboratory. Students are given tours of Lab property and lectures on a variety of subjects.

During the summer of 2013, students toured the Strategic Computing Complex (SCC), which houses the supercomputing system at Los Alamos. The SCC also has "the cave," a viewing room that allows researchers to walk around 3D visualizations of their computer simulations and even interact with them. They also went to Technical Area 55, home of the Plutonium Facility.

Some students were taken to the Nevada National Security Site, where they performed experiments in the Device Assembly Facility. They spent time touring and visiting craters created by underground nuclear tests (which ended in 1992) and the U1a underground test facility, where subcritical (no nuclear yield) tests are conducted. In addition to visiting these important locations, students learned about a wide range of science and technology from experts. They were able to attend lectures on a variety of subjects, such as the development of an HIV vaccine and Los Alamos' involvement with ChemCam, a laser on the Mars mission's Curiosity rover. The laser vaporizes small rock or soil samples so their elemental composition can be determined.

The students were able to meet Laboratory Director Charlie McMillan and Admirals Richard Mies (retired) and William McRaven, commander of the U.S. Special Operations Command.

"In the military, the director of the Laboratory would be considered a four-star general," says Butler, "but here you call him by his first name. That's cool."

LANL also strives to give students an opportunity to learn about New Mexico. Students are encouraged to explore Los Alamos and the surrounding areas, which is something they can do both individually, in groups, and with their mentors. Michael Fitzgibbon, a midshipman from Annapolis,

West Point cadet Christopher Wink, along with his LANL mentor David Holtkamp and LANL staff member Jeremy Payton, stand at the Sedan Crater at the Nevada National Security Site. The Sedan Crater, the largest man-made crater in the United States, is the result of the July 6, 1962, Sedan nuclear test. The crater is over 300 feet deep and 1,280 feet in diameter. (Photo: Los Alamos)

Steven Sloan, a West Point cadet, looks into a glovebox in the Plutonium Facility. Missions within the facility include plutonium processing in support of stockpile stewardship, manufacture of plutonium energy sources for space missions, and materials disposition in support of nuclear nonproliferation, nuclear counterterrorism, and nuclear energy. (Photo: Los Alamos)

said he went running with his mentor in the Jemez Mountains, just west of Los Alamos. Groups of students also climbed Wheeler Peak, the tallest mountain in New Mexico; rafted down the Rio Grande; and went off-roading and hiking in the mountains.

Other students, including Wink and Sloan, explored New Mexico's rich Native American history and culture by visiting archeological sites like Bandelier National Monument and Taos Pueblo, a Native American community that is over 1,000 years old.

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SARA students are encouraged to experience and enjoy LANL and the surrounding area because the Lab wants students to look at their time in Los Alamos as more than just an educational experience. Working at the Lab is a great way for students to experience the many adventures in and out of Los Alamos and to create connections that will last a lifetime. They work with mentors that care about students as individuals. Goorley says mentoring is about building connections with both the military and the students themselves. Stevens also believes that mentoring SARA students is about more than just sharing scientific expertise. "I think it's very important to bring students into your family," says Stevens. "I want to show students not only how scientists work, but also how they live."

Students said they enjoyed spending time with their mentors, and they also felt LANL was an unparalleled learning opportunity.

"It's such an enlightening experience to be around this sort of brain power in this sort of environment," says McLaughlin. "You can ask whatever questions you want and learn more here in a week than maybe in six months anywhere else."

Sloan said the SARA program helped him understand the complexities and complications of nuclear stockpile stewardship and gave him the opportunity to connect with

lots of interesting people. Phillip Ellsworth, a midshipman from Annapolis who worked in the Shock and Detonation Physics group, said his education at the Lab would be helpful because he plans to work on submarines with weapons designed at LANL.

Many students also said their internship with LANL will help them make important career decisions. Jones said working at the Lab has helped him think about what he wants to do after his military commitment and what he wants to spend his time working on.

"We hope that, based on their summer experience, they would consider working here," says Ventura.

It seems Ventura's hope is well founded. Students have already asked about coming back to the Lab for another summer.

~Marissa Higdon

Annapolis midshipmen stand at the top of Wheeler Peak. Wheeler Peak summit is 13,167 feet, the highest point in New Mexico. (Photo: Los Alamos)